Remarks

Reconsideration of this Application is respectfully requested.

Upon entry of the foregoing amendment, claims 2-5, 7, 9, and 10 are pending in the application, with claims 3 and 9 being the independent claims. Claims 3 and 9 are sought to be amended. These changes are believed to introduce no new matter, and their entry is respectfully requested.

Based on the above amendments and the following remarks, Applicant respectfully requests that the Examiner reconsider all outstanding rejections and that they be withdrawn.

Rejections Under 35 U.S.C. § 103

Claims 2-5, 7, 9, and 10 were rejected under 35 U.S.C. § 103(a) as being unpatentable over U.S. Patent No. 6,532,017 to Knittel *et al.* (hereinafter "Knittel") in view of U.S. Patent No. 5,760,781 to Kaufman *et al.* (hereinafter "Kaufman"). (*See* Office Action at ¶ 6.) Applicant respectfully traverses these rejections.

Amended independent claim 3 recites (emphasis added):

A method for presenting three-dimensional computer graphics images using multiple graphics processing units, comprising the steps of:
(1)　allocating, to the multiple graphics processing units, a set of three-dimensional computer graphics data such that said allocated set of three-dimensional computer graphics data corresponds to *substantially all of a scene* that lies within rectangular subvolumes to which the multiple graphics processing units have been assigned;
(2)　determining a viewing position, wherein said determined viewing position determines an aspect of said allocated set of three-dimensional computer graphics data to be rendered;

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(3)   communicating said determined viewing position to the multiple graphics processing units;

(4)   rendering, by the multiple graphics processing units, *substantially all* of said allocated set of three-dimensional computer graphics data, *rather than a sample* of said allocated set of three-dimensional computer graphics data;

(5)   combining said rendered set of three-dimensional computer graphics data with image combiners, wherein outputs from the multiple graphics processing units are direct inputs to first stage image combiners and outputs from at least two of the first stage image combiners are direct inputs to a second stage image combiner, thereby producing a three-dimensional computer graphics image; and

(6)   presenting, for viewing, said combined three-dimensional computer graphics image.

Independent claim 9 has been amended in a similar manner.

Neither Knittel nor Kaufman, alone or in combination, discloses, teaches, or suggests rendering *substantially all* of a set of three-dimensional computer graphics data, *rather than a sample* of the set of three-dimensional computer graphics data, in which the three-dimensional computer graphics data is allocated to multiple graphics processing units and corresponds to *substantially all* of a scene that lies within rectangular subvolumes to which the multiple graphics processing units have been assigned.

In Knittel, the viewing position determines a *sample* of the set of the three-dimensional computer graphics data to be rendered. Knittel at figures 4, 5A, and 5B and at column 9, lines 20-59 recites:

FIG. 4 illustrates the processing of an individual ray 18. Ray 18 passes through the three dimensional volume data set 10 at some angle, passing near or possibly through voxel positions 12, and accumulates at sample points 20 along each ray. The value at each sample point is synthesized as illustrated at 21 by an interpolation unit 104 (see FIG. 5), and the gradient at each sample point is calculated as illustrated at 23 by a gradient estimation unit 112 (see FIG. 5). The sample point values from sample point 20 and the gradient 25 for each sample point are then processed to assign color, brightness or intensity, and transparency or opacity to each sample. As illustrated at 27, this processing is done via pipeline processing in which red, green and blue hues

as well as intensity and opacity or transparency are calculated. Finally, the colors, levels of brightness, and transparencies assigned to all of the samples along all of the rays are applied as illustrated at **29** to a compositing unit **124** that mathematically combines the sample values into pixels depicting the resulting image **32** for display on image plane **16**.

The calculation of the color, brightness or intensity, and transparency of sample points **20** is done in two parts. In one part, a function such as trilinear interpolation is utilized to take the weighted average of the values of the eight voxels in a cubic arrangement immediately surrounding the sample point **20**. The resulting average is then used to assign a color and opacity or transparency to the sample point by some transfer function. In the other part of the calculation, the gradient of the sample values at each sample point **20** is estimated by a method such as taking the differences between nearby sample points. It will be appreciated that these two calculations can be implemented in either order or in parallel with each other to produce equivalent results. The gradient is used in a lighting calculation to determine the brightness of the sample point. Lighting calculations are well known in the computer graphics art and are described, for example, in the textbook "Computer Graphics: Principles and Practice," 2nd edition, by J. Foley, A. van Dam, S. Feiner, and J. Hughes, published by Addison Wesley of Reading, Mass., in 1990.

Likewise, in Kaufman, the viewing position determines a *sample* of the set of the three-dimensional computer graphics data to be rendered. Kaufman at figure 6 and at column 9, lines 22-26 recites "[a]s shown in FIG. **6**, the ray projection mechanism includes a plurality of input ports **34** for receiving the plurality of interpolated sample signals for each of the plurality of continuous viewing rays." Furthermore, Kaufman at figure 2 and at column 7, lines 48-55 recites:

> [r]eferring . . . to FIG. **3**, the apparatus of the present invention **20** also preferably includes an interpolation mechanism **28** coupled to the 2-D buffers **24**. In a preferred embodiment of the invention, the interpolation device is a tri-linear (TRILIN) interpolation mechanism which receives information about continuous viewing rays that are cast, preferably from the selected viewing position, through the cubic frame buffer **22**.

Also, the Abstract of Kaufman, *inter alia*, recites:

> Viewing rays are cast from the viewing position into a cubic frame buffer and beams of voxels, which are parallel to the face of the cubic frame buffer, are accessed. At evenly spaced sample points along each viewing ray, each

sample point is tri-linearly interpolated using values of surrounding voxels. Central differences of voxels around the sample points yield a gradient which is used as a surface normal approximation. Using the gradient and the interpolated sample values, a local shading model is applied and a sample opacity is assigned. Finally, ray samples along the ray are composited into pixel values and provided to a display device to produce an image.

Accordingly, claims 3 and 9 are patentable over Knittel in view of Kaufman. Claims 2, 4, 5, 7, and 10, which depend upon claims 3 or 9, are also patentable over Knittel in view of Kaufman. Therefore, Applicant respectfully requests that the Examiner remove his rejections of claims 2-5, 7, 9, and 10 under 35 U.S.C. § 103(a) and pass these claims to allowance.
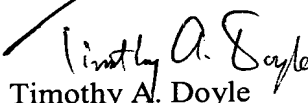
Conclusion

All of the stated grounds of rejection have been traversed. Applicant therefore respectfully requests that the Examiner reconsider all presently outstanding rejections and that they be withdrawn. Applicant believes that a full and complete reply has been made to the outstanding Office Action and, as such, the present application is in condition for allowance. If the Examiner believes, for any reason, that personal communication will expedite prosecution of this application, the Examiner is invited to telephone the undersigned at the number provided.

Prompt and favorable consideration of this Amendment and Reply is respectfully requested.

Respectfully submitted,

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